17. What Lessons Have Been Learned From Early Low-Level Radioactive Waste Disposal Facilities?

The United States has been disposing of low-level radioactive waste in shallow land burial facilities since the early 1960s. It is worth noting that none of these sites have been responible for exposures to people in excess of the 25 millirem annual limit set by federal regulations. Nevertheless, experience with these facilities has provided some lessons about how various siting, design, and operations choices affect a facility's ability to meet the objectives of low-level waste disposal. These lessons have provided valuable information for design, construction, and operation of future facilities. Many of them have been incorporated into the regulations that govern low-level waste disposal (Title 10, Part 61 of the Code of Federal Regulations). This Fact Sheet discusses some of the lessons learned.

➤ Past and Present Disposal Facilities

Six commercial low-level radioactive waste disposal facilities have operated in the United States: Beatty, Nevada; Maxey Flats, Kentucky; West Valley, New York; Richland, Washington; Sheffield, Illinois; and Barnwell, South Carolina (see Figure 1). Only the sites in Washington and South Carolina are currently open. The Nevada site closed at the end of 1992, and the other three sites closed between 1975 and 1978. Shallow land burial in excavated trenches has been used at all six sites.

Experience gained from the first-generation facilities in humid climates was used to improve the design and operation of Barnwell, the most recent facility to open. In the future, other approaches to disposal such as above-grade vaults, below-grade vaults, and earth-mounded concrete bunkers are likely to be used, providing further improvement over current land burial techniques.

The primary objective of a low-level radioactive waste disposal facility is to isolate waste from people and the environment until the **radionuclides** (radioactive atoms) in the waste have decayed to levels at which their hazard is negligible.

A fundamental concern that must be addressed when attempting to isolate low-level waste in a disposal facility on land is preventing movement of the radionuclides out

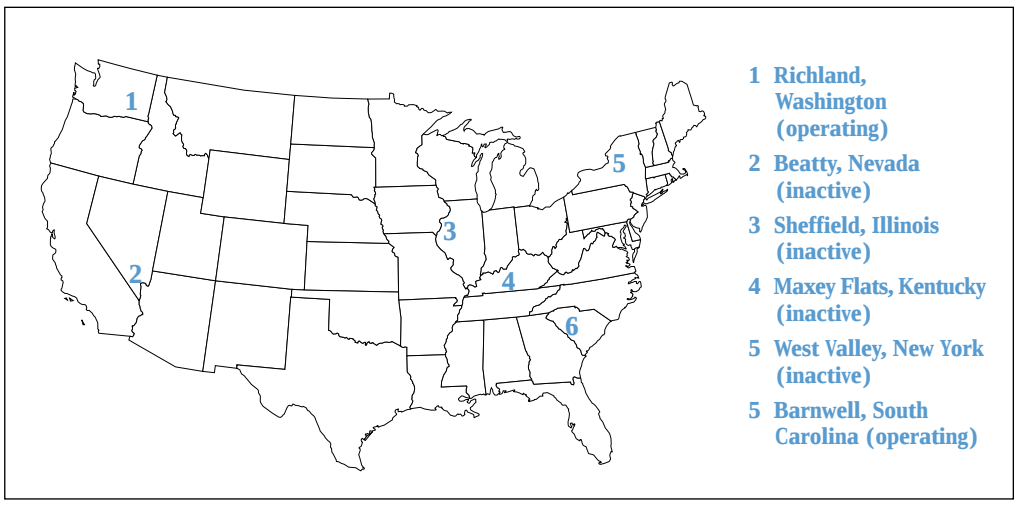

Figure 1. **Low-Level Radioactive Waste Disposal Facilities**

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Figure 2. **Bathtub Effect**

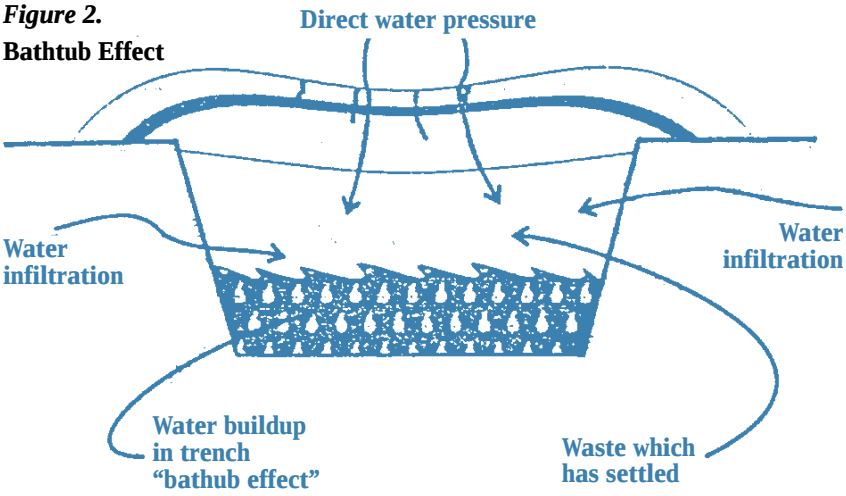


Figure 3. **Intended Cap Configuration**

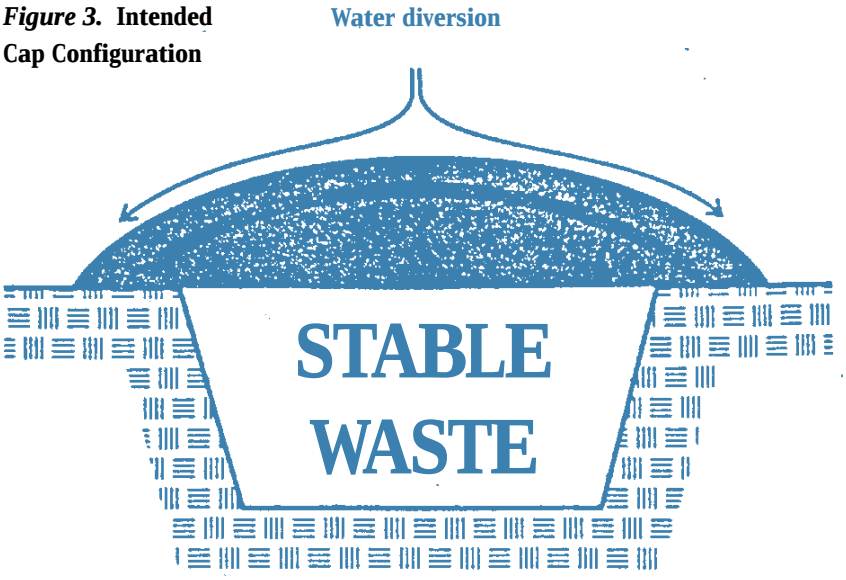
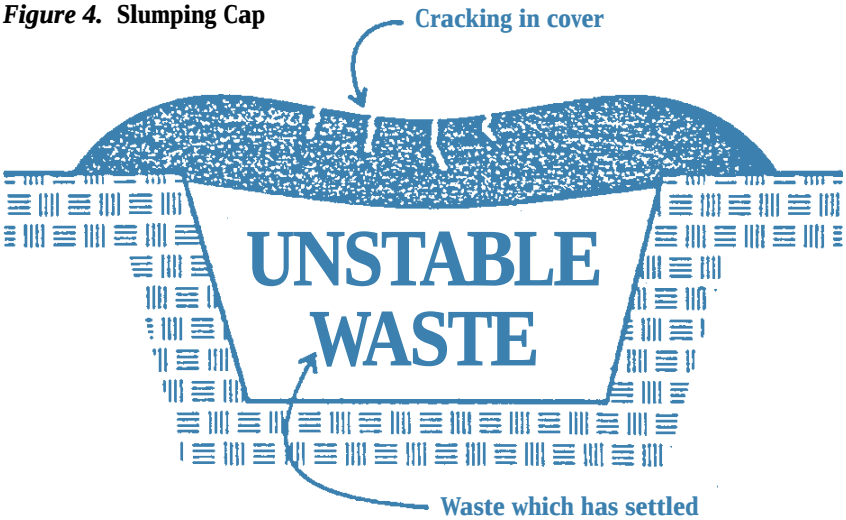


Figure 4. **Slumping Cap**



of the disposal facility, or **radionuclide migration.** The most important factor in achieving this is isolating the waste from water, or **hydrologic isolation.**

Extensive monitoring of all of the commercial low-level waste disposal sites has provided valuable information on hydrologic isolation and radionuclide migration. Analyses of the data help focus on the site characteristics, design features, and operating procedures that affect a facility's ability to maintain hydrologic isolation and prevent radionuclide migration.

➤ Factors That Affect Hydrologic Isolation

The buildup of water in burial trenches at some closed sites (loss of hydrologic isolation) was caused by a greater rate of seepage into the trenches than out of them. This phenomenon is known as the **bathtub effect** (Figure 2). It is of concern because water in a trench can corrode waste containers and lead to migration of radioactive material. At both the Maxey Flats and West Valley sites, water buildup in the trenches led to site closure and corrective actions. The remaining four commercial sites did not exhibit the bathtub effect, most likely because of differences in their precipitation rates and/or differences in soil characteristics.

One factor which led to increased seepage of water into trenches at some closed sites was subsidence, or slumping, of the cap. A cap is a layered barrier of packed clay and other materials covering a waste disposal trench to divert water away from the trench (Figure 3). Very little water can pass through the cap. However, if the cap slumps and cracks, water can seep easily into the trench (Figure 4). Containers in some early facilities were not always full, and were not carefully stacked. So they settled over time, causing the cap above them to shift and crack.

Lesson: *Waste containers must be in a structurally stable form, arranged carefully*

in the disposal facility, and the spaces between containers filled to avoid settling.

At Barnwell, a layer of sand is placed on the bottom of each trench to provide an even foundation for waste containers and to ensure that water seeping into the trench will drain away from the waste. Naturally occurring layers of sand in the trench walls are replaced with compacted clay to reduce seepage of water into the trenches from the surrounding soil. Low-level radioactive waste is stacked in the trenches and spaces between containers are filled with sand to provide drainage paths away from the waste.

Lesson: *Careful attention must be paid to design and operating procedures to ensure facility performance.*

➤ Factors That Affect Radionuclide Migration

Migration of radionuclides may occur when water comes into contact with low-level radioactive waste and carries radionuclides into the surrounding soil. The radionuclides are likely to migrate more rapidly when coarse-grained deposits, like sand and gravel, exist in the surrounding soil. Migration from disposal trenches has occurred at both the Maxey Flats and Sheffield sites. In both cases, follow-up investigations revealed the presence of coarse-grained deposits which were more extensive than discovered by the initial, very limited site investigation.

Lesson: *Thorough geologic, soil, and water analyses must be done to determine the site characteristics before a facility can be built.*

At Barnwell, some migration of radioactive hydrogen (tritium) from the buried waste in the oldest trenches has occurred. Those trenches have been recapped, which has slowed the migration of tritium.

Lesson: *It is critical that facilities be designed to keep water out of trenches to reduce radionuclide migration.*

Disposing of low-level radioactive waste in liquid form can increase migration of radionuclides away from the disposal facility. Much liquid low-level waste has been found to be corrosive and can damage containers in which it is buried. If the liquid waste leaks from its container, it can migrate from the disposal facility.

Lesson: *Liquid waste must not be put into a disposal facility.*

➤ Other Lessons About Operating Procedures

Other lessons have been learned involving operating procedures that can improve worker safety. Questionable site management and disposal practices at Maxey Flats prior to its closure contributed to ground surface contamination from accidental spillage of waste, direct disposal of contaminated liquids on the slopes of the site, and spreading of liquid from the trenches by earth moving equipment. At Beatty, employees removed a contaminated cement mixer and other tools which were brought to the site as radioactive waste, and used them in local construction projects.

Lesson: *A strong quality assurance program, employee training, and regulatory oversight are essential.*

Operators of the Beatty site developed a third party inspection system which all generators shipping to Beatty were required to accept as a condition for receiving a permit to use the disposal site. Under the inspection system, which was conducted by a contractor for the state, permits were issued only after an initial audit was performed on-site. The purpose of the audit was to verify compliance by the generator with federal and state regulations and with the disposal facility's license requirements. The inspection contractor also performed unannounced follow-up audits of the generators. Fines of up to $20,000 per incident, suspension of permits, and criminal penalties could result from permit infractions.

Lesson: *Audits and regular inspections*

help to ensure that the waste reaching the disposal site is of acceptable content and form.

For More Information

If you want to read more about the lessons that have been learned from existing low-level radioactive waste disposal facilities, some of the references listed below may be helpful.

- *Directions in Low-Level Radioactive Waste Management: A Brief History of Commercial Low-Level Radioactive Waste Disposal*, The National Low-Level Waste Management Program, (DOE/LLW-103), October 1990.
- Edward L. Gershey et. al., *Low-Level Radioactive Waste From Cradle to Grave*, Van Nostrand Reinhold, New York, 1990.
- Robert E. Berlin and Catherine C. Stanton,*Radioactive Waste Management*, John Wiley & Sons, New York, 1989.

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